Hypothermia in Iranian newborns

Incidence, risk factors and related complications

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ABSTRACT

Objective: To determine the incidence rate and factors associated with hypothermia in Iranian newborns and to discover the effect of hypothermia on neonatal morbidity and mortality.

Methods: We selected a random sample of 1952 neonates using a multistage sampling technique from February 2004 to February 2005 in University Teaching Hospitals in Iran. We measured repeatedly at different time points the rectal temperature of these newborns. At each time of measurement, those with rectal temperature <36˚C were considered as hypothermic.

Results: The obtained results showed that approximately one third of newborns became hypothermic immediately after birth. In addition, the regression analysis revealed that low birth weights, prematures, low apgar scores, infants of multiple pregnancies and those who received cardiopulmonary resuscitation had higher risk for being hypothermic. It was also found that hypothermia increases the risk of metabolic acidosis, jaundice, respiratory distress, hypoglycemia, pulmonary hemorrhage and death, regardless of the newborn's weight and gestational age.

Conclusion: There is an urgent need to train mothers and all levels of neonatal care staff to control this health problem in our country.

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Hypothermia is an important cause of morbidity, and occasionally mortality, in newborn.[1] In 1958, Silverman et al[2] and in 1964, Buetow and Klein[3] reported the adverse effects of hypothermia on viability and hope for life in premature and low birth weight neonates. Low body temperature in newborns may lead to an increased rate of basal metabolism, peripheral vasoconstriction, decreased peripheral perfusion, tissue ischemia and finally metabolic acidosis.[4] Vascular changes in the lungs may lead to decreased ventilation, increased demand for oxygen and worsening of respiratory distress.[5] Meanwhile, acidosis and hypoxia can predispose to pulmonary hemorrhage and disseminated intravascular coagulation.[4] Hepatocyte ischemia affects liver functions and may cause indirect hyperbilirubinemia. In addition, the high metabolic rate leads to higher glucose consumption and hypoglycemia.[5] In many parts of the world, especially in developing countries, the neonatal health personnel are unaware of the importance of keeping babies warm by simple methods such as drying and wrapping immediately after birth, avoiding harmful practices, encouraging early breast

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feeding and keeping newborns in close contact with their mothers. According to the reports of World Health Organization (WHO), studies in India, Ethiopia, China and Nepal have shown that most of newborns became hypothermic soon after birth.[6] Some local reports in different parts of Iran revealed that neonatal hypothermia is a major problem in our country. Hence, we decided to design a large sample epidemiologic survey to obtain more accurate information about this health problem. The main goals of the present study are to estimate the incidence rate of neonatal hypothermia and to identify some of the most important risk factors or risk indicators of this health problem in university teaching hospitals of Iran. We also aim to determine the effect of hypothermia on neonatal morbidity and mortality.

Methods. We carried out this repeated measures the epidemiologic study from February 2004 to February 2005 in different provinces of Iran. At first, using a multistage sampling technique, 10 provinces were randomly chosen in different parts of the country. At the second stage, a random sample of university teaching hospitals was selected in each province. Finally, at the third stage, 1952 newly born infants were randomly selected in these hospitals. The aims of this survey were precisely explained to the neonates' parents, and then the study consent was obtained from them. For each newborn, a questionnaire including personal characteristics and other required information was filled out. In this study, the rectal temperature of each newborn was measured repeatedly using a digital low-reading rectal thermometer at the following time points: Time 1 - immediately after birth in the operating room; Time 2 - few minutes after admission to the neonatal unit (levels I, II, III of nursery care); Time 3, 4 and 5 - one, 3, and 6 hours after admission to the neonatal unit. At each time of measurement, if the body temperature of a newborn was <36˚C, the patient was considered as hypothermic and if their body temperature was between 36˚C and 38˚C, they were considered as normothermic. Therefore, the binary response variable for each newborn at each time point can be written as: 0=normothermic, 1=hypothermic. If a newborn was hypothermic, the patient was re-warmed according to the WHO recommendations.[6] Hyperthermic neonates (newborns with a rectal temperature >38˚C) and those with different anomalies were excluded. In the present study, we aimed to assess the effect of the following risk factors or risk indicators on neonatal hypothermia: gender of neonate (0 = boy, 1 = girl); neonate's birth weight (1 = <1500 grams or very low birth weight, 2 = between 1500 and 2500 grams or low birth weight, 3 = >2500 grams); gestational age (0 = ≥37 weeks, 1 = <37 weeks); apgar score at each time of measurement (0 = ≥8, 1 = <8); type of pregnancy (0 = single, 1 = multiple); cardiopulmonary resuscitation (CPR) (0 = not received, 1 = received). Another goal of the present study was to assess the effect of hypothermia on neonatal mortality and morbidity. In this context, we evaluated the relationship between hypothermia and neonatal death, respiratory distress (within the first 6 hours of life) as well as hypoglycemia, jaundice (to the degree requiring intervention), metabolic acidosis (pH <7.25 and HCO_3 <20), disseminated intravascular coagulopathy (DIC), pulmonary hemorrhage and scleroderma during the first three days of life. In the statistical analyses, percents and appropriate frequency tables were utilized for the descriptive purposes. Additionally, because of repeated binary inherent of the response variable (being hypothermic or not at each time of measurement), a random-effects logistic regression model was used to determine the relationship between the described factors and neonatal hypothermia. Finally, the Fisher's exact and chi-square tests were used to assess the effect of hypothermia on neonatal mortality and morbidity. The random-effects modeling process was performed using SAS software version 8.[7] For other purposes, the SPSS software version 12 was used. P-values less than 0.05 were considered statistically significant.

Results. In this study, we evaluated a random sample of 1952 Iranian neonates. This sample consisted of 970 girls (49.7%) and 982 boys (50.3%). **Table 1** shows the characteristics of newborns.

Table 1 - Characteristics of the newborns.

Characteristics	n	(%)
Weight		
<1500 grms (VLBW)	82	(4.2)
1500-2500 grams (LBW)	525	(26.9)
≥2500gr	1345	(68.9)
Gestational age		
<37 weeks (preterm)	392	(20.1)
≥37 weeks	1560	(79.9)
Apgar score*		
<8 (low apgar score)	176	(9)
≥8	1776	(91)
Type of pregnancy†		
Single	1904	(98.9)
Multiple	22	(1.1)
Cardiopulmonary resuscitation		
Not received	102	(5.2)
Received	1850	(94.8)

*Immediately after birth, †1952 neonates from 1926 deliveries, VLBW - very low birth weight, LBW - low birth weight

Table 2 - Incidence rate of neonatal hypothermia at different time points.

Neonatal hypothermia	Time of measurement				
	Time 1	**Time 2**	**Time 3**	**Time 4**	**Time 5**
Hypothermic	659 (33.8)	186 (9.5)	30 (1.5)	8 (0.5)	3 (0.2)
Normothermic	1293 (66.2)	1776 (90.5)	1922 (98.5)	1944 (99.5)	1949 (99.8)
Total	**1952 (100)**	**(1952) (100)**	**(1952) (100)**	**(1952) (100)**	**(1952) (100)**

Table 3 - Multivariate random-effects logistic regression modeling for the analysis of the risk factors and risk indicators.

Factor	Estimate*	SE#	*p*-value†	Odds ratio‡
Gender of neonate				
Female	0.234	0.166	0.159	1.26
Male	Reference category			
Weight of neonate				
Very low birth weight	2.018	0.331	<0.001	7.52
Low birth weight	1.228	0.211	<0.001	3.41
≥2500 grms	Reference category			
Gestational age				
<37 weeks	1.156	0.217	<0.001	3.18
≥37 weeks	Reference category			
Apgar scores				
<8	0.947	0.304	0.002	2.58
≥8	Reference category			
Pregnancy type				
Multiple	0.739	0.215	0.001	2.09
Single	Reference category			
Cardiopulmonary resuscitation				
Received	0.931	0.246	<0.001	2.54
Not received	Reference category			

*estimate of the model parameter, #standard error of the estimate, †2- sided *p*-value, ‡odds ratio

Table 4 - Relationship between hypothermia and neonatal complications.

Complications	Normothermic %	Hypothermic %	Odds ratio	Confidence interval
Acidosis	1.2	7.9	7.30	4.08-13.0
Jaundice	5.3	15.5	3.30	2.39-4.56
Respiratory distress	5.8	16.4	3.18	2.33-4.34
Hypoglycemia	7.0	12.1	1.83	1.33-2.50
Pulmonary hemorrhage	0.5	1.4	2.97	1.05-8.38
Disseminated intravascular coagulopathy	0.1	0.9	11.87	*
Scleroderma	0.1	0.2	1.96	*
Death	1.9	5.8	3.10	1.86-5.19

*Not computed (because of inadequate sample size)

One of the most important goals of the present research is to estimate the incidence rate of neonatal hypothermia at different times of measurement. **Table 2** shows the incidence rate of hypothermia at different time points. Univariate statistical analyses for the first time point data (immediately after birth in the operating room) showed that hypothermia was more prevalent in very low birth weight (VLBW) and low birth weight (LBW) newborns compared to those with more than 2500 grams weight (53.2% versus 15.5%, $p<0.001$). Moreover, the incidence rate of neonatal hypothermia in prematures was significantly higher than full term neonates (57.6% versus 19.1%, $p<0.001$).

Table 3 shows the results of multivariate random-effects modeling for describing the effect of the introduced risk factors or risk indicators on neonatal hypothermia. These results show that all the described factors, except gender of neonate, were significantly associated with neonatal hypothermia. In other words, VLBWs, LBWs, preterms, low apgar scores, infants of multiple pregnancies and those received cardiopulmonary resuscitation had higher risk for being hypothermic. The estimates of the regression parameters in **Table 3** may be more comprehensible in terms of the odds ratios. These odds show the chance of being hypothermic for a specific sub-group compared to the reference category.

Table 4 shows the results of chi-square and Fisher's exact tests for evaluating the effect of hypothermia on neonatal mortality and morbidity. In this analysis, a newborn was considered as hypothermic, if she/he had low rectal temperature (<36˚C) at least at one of the consecutive time points. These results show a significant relation between hypothermia and metabolic acidosis, jaundice, respiratory distress, hypoglycemia and pulmonary hemorrhage. Due to inadequate sample size of the newborns with DIC and scleroderma, our findings did not show any significant relationship between neonatal hypothermia and DIC or scleroderma. As the result, comparing the death rate in hypothermic and normothermic newborns (5.8% versus 1.9%, $p<0.001$) showed a strong association between hypothermia and neonatal mortality.

Discussion. In the previous decades, most of the studies focused on the effect of hypothermia on neonatal mortality and morbidity among preterm and LBW infants.[2-6] In this study, it was revealed that hypothermia increases the rate of neonatal complications such as metabolic acidosis, respiratory distress, hypoglycemia, pulmonary hemorrhage and death, regardless of the neonate's weight and gestational age. In this context, the metabolic distress was the most prevalent problem among hypothermic newborns. This high prevalence may be explained by increased metabolic demand, which results in metabolic acidosis and compensatory hyperventilation. This study failed to show the effect of hypothermia on DIC and scleroderma. It seems that a study with a large sample size (or with a different design) is needed to prove the possible effect of hypothermia on DIC or scleroderma. However, a study by Xiao-Cheng et al,[8] in China on a large group of newborns showed a close relationship between scleroderma and hypothermia. The results of the present study showed that about one third of the Iranian neonates delivered at university teaching hospitals suffered from hypothermia soon after birth. This rate was 15.5% in normal birth weight and 19.7% in full term babies. The evaluation of the previous studies shows that the incidence pattern of neonatal hypothermia is not the same in developed and developing countries. In developed countries, the incidence of neonatal hypothermia is mostly confined to outborn, LBW, premature and other high risk neonates. For instance, a study on VLBW newly born infants in Canada showed that the overall incidence of moderate to severe hypothermia (body temperature less than 35˚C) on admission was 11.5-12.5% among premature newborns.[9] In USA, a retrospective study revealed that 45% of outborn VLBW infants were hypothermic (body temperature <36.3˚C) on admission.[5] Another study in Australia showed that 17% of neonates became hypothermic during transport (axillary temperature <36˚C).[10] In developing countries, however, this health problem is highly prevalent even in healthy full term, inborn and normal birth weight newborns. For instance, a study on 500 inborns in Nepal revealed that 85% of neonates were hypothermic (body temperature <36˚C) 2 hours after delivery.[11] In North India, a research on 189 term healthy neonates delivered at home showed that the incidence rate of hypothermia (axillary temperature <35.6˚C) 24 hours after delivery was 19.1% in winter and 3.1% in summer.[12] In our survey, the results of the logistic regression analysis showed that LBW, premature and low apgar score newborns had higher risk for being hypothermic. These findings are in agreed with the obtained results from other surveys in different countries.[13-16] In addition, we found that hypothermia is more prevalent in neonates of multiple pregnancies and those received cardio-pulmonary resuscitation. We could not find any significant association between gender of neonates and hypothermia. These findings can help us to train the neonatal care personnel for a better management of the high risk newborns. Hypothermia in newborn babies is a major problem even in tropical countries despite warm environmental conditions. Our findings in the present study showed the adverse effects of hypothermia on neonate's health and survival. In this context, the nursing staff plays a

vital role in controlling this health problem in developing countries such as Iran. Implementing mother-infant kangaroo cares, thermal management practices and WHO clinical guidelines as well as intensive care of LBW, preterm, low apgar score and other high risk babies will significantly reduce the incidence rate of neonatal hypothermia and its subsequent problems. Therefore, there is an urgent need to increase awareness about the consequences of hypothermia and train mothers and all levels of neonatal care staff to control this health problem in our country.

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